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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK VOLUME 157
KC-10A IN-FLIGHT CRE. (U) AIR FORCE AEROSPACE MEDICAL
RESEARCH LAB WRIGHT-PATTERSON AFB. H K HILLE SEP 82
AMRL-TR-75-50-VOL-157 F/G 1/2

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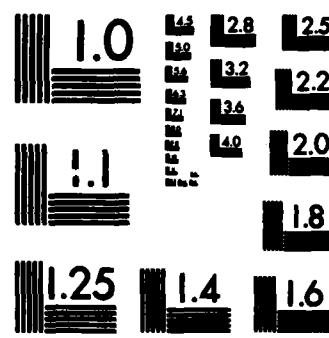
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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

Volume 157

KC-10A IN-FLIGHT CREW NOISE

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This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



HENNING E. VON GIERKE, Dr Ing
Director
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Air Force Aerospace Medical Research Laboratory

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AMRL-TR-75-50, Vol. 157	2. GOVT ACCESSION NO. <i>AD-A220 507</i>	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK: KC-10A In-Flight Crew Noise	5. TYPE OF REPORT & PERIOD COVERED Volume 157 of a series	
7. AUTHOR(s) Harald K. Hille	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Aerospace Medical Research Laboratory Aerospace Medical Division, Air Force Systems Command, Wright-Patterson AFB, OH 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62202F 72310918	
11. CONTROLLING OFFICE NAME AND ADDRESS Same as above	12. REPORT DATE September 1982	
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	13. NUMBER OF PAGES 18	
	15. SECURITY CLASS. (of this report) Unclassified	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Noise Noise Environments Bioenvironmental Noise In-flight Crew Noise KC-10A Aircraft		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → The KC-10A is the standard USAF tanker-transport aircraft with high-speed, high-altitude refueling and long range transport capability. This report provides measured data defining the bioacoustic environments at flight crew/ passenger locations inside this helicopter during normal flight operations. Data are reported for 24 locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise levels,		

and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. ←

PREFACE

This report was prepared by the Biodynamic Environment Branch, Air Force Aerospace Medical Research Laboratory, under Project/Task 723109, Communication and Performance Capability and Operational Noises. The author acknowledges the efforts of Mr. John Cole who established the data analysis requirements, Mr. Henry Mohlman, and Mr. Fred Lampley of the University of Dayton who assisted in the mechanics of data processing and Mrs. Norma Peachey who typed this report and prepared it for publication.

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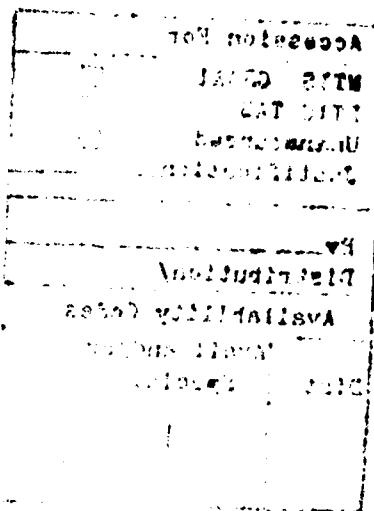


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INTRODUCTION

The KC-10A is a USAF tanker-transport aircraft with high-speed high-altitude refueling and long range transport capability. This aircraft, which is manufactured by the McDonnell Douglas Corporation, is powered by three CF-6-50C1 turbofan engines each rated at 52,500 lbs. maximum takeoff thrust. The engines are manufactured by the General Electric Company, Aircraft Engine Group.

This volume provides measured and extrapolated data defining bioacoustic environments produced inside this helicopter. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the KC-10A aircraft.

This volume is one of a series published by the Air Force Aerospace Medical Research Laboratory (AFAMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during ground operations of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing. Refer to Volume 1 (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published.

1. Cole, John N., USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application, AMRL-TR-75-50(1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a standard-configured KC-10A aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard KC-10A environments, but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at various flight crew and passenger locations. Table 1 lists the measurement locations and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

The microphone position was at ear level external to headgear in a region 0.2-0.3 meter from the head when an individual was present. At unoccupied locations, measurements were made at ear level throughout a volume where the head would normally be located. In both cases, the microphone was randomly moved throughout a spherical volume approximately 0.3 meter in diameter and the resultant samples analyzed using a 4- or 8-second integration time to obtain a power-averaged level, which effectively smooths out short-duration fluctuations and best describes the exposure.

Although the presence of a crew member or passenger at a measurement location affects the resultant sound field, the magnitude of such effects is generally small and not significant in determining exposure limits or voice communication capabilities. Consequently, no distinction is made in this report between occupied and unoccupied measurement locations.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the KC-10A aircraft at the 24 specified locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1
MEASUREMENT LOCATIONS AND TEST CONDITIONS

KC-10A, Barksdale AFB, 21 June 1982

LOCATION	POSITION	HEIGHT ABOVE DECK
1	Cockpit Between Pilot & Copilot	Seated Head Level
2	Cockpit Navigator/Flight Engineer	Seated Head Level
3	Station 480, Seat at Right Sidewall	40" Above Deck
4	Station 480, Seat at Centerline	40" Above Deck
5	Station 480, Seat at Left Sidewall	40" Above Deck
6	Top Bunk, Right Side, Curtain Closed	40" Above Deck
7	Top Bunk, Left Side, Curtain Closed	40" Above Deck
8	Bottom Bunk, Left Side, Curtain Closed	40" Above Deck
9	Bottom Bunk, Left Side, Curtain Closed	40" Above Deck
10	Station 1238, Centerline	40" Above Deck
11	Station 1238, Left Sidewall	40" Above Deck
12	Station 1238, Right Sidewall	40" Above Deck
13	Station 1538, Right Sidewall	40" Above Deck
14	Station 1538, Centerline	40" Above Deck
15	Station 1538, Left Sidewall	40" Above Deck
16	Station 1738, Left Sidewall	40" Above Deck
17	Station 1738, Centerline	40" Above Deck
18	Station 1738, Right Sidewall	40" Above Deck
19	Boom Operating Area, Middle Seat	Seated Head Level
20	Boom Operating Area, Pumps On, Middle Seat	Seated Head Level
21	Boom Operating Area, Pumps On, Left Seat	Seated Head Level
22	Boom Operating Area, Pumps On, Right Seat	Seated Head Level
23	Boom Operating Area, Retracting Boom, Doors Open	Seated Head Level
24	Boom Operating Area, Doors Closed	Seated Head Level

CONDITION	DESCRIPTION
A	Engine Start
B	Taxi
C	All Engines Idle, Ground Runup
D	Takeoff/Roll
E	Climb to 5,000 ft.
F	Climb to 10,000 ft.
G	Climb to 20,000 ft. - 320 KIAS
H	Cruise - 37,000 ft. 0.8M
I	AC - Automatic Mode With Both Pads Set on Auto
J	Cruise - 29,000 ft. - 325 KIAS
K	Approach KC-135, Light Door Closed
L	Cruise - 29,000 ft. - Receiving Fuel From KC-135
M	Cruise - 29,000 ft. - 325 KIAS
N	Approach KC-135, Light Door Open
O	Descent to 20,000 ft. - 320 KIAS
P	Approach - 3,000 ft. - 150 KIAS
Q	Final Approach - 1,000 ft., Gear Down
R	Landing/Roll

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 1/3 OCTAVE BAND

IDENTIFICATION:

OMEGA 3.2
TEST BM-0082-001
RUN 01

02 AUG 82

PAGE F1

OPERATION:

NOISE SOURCE/SUBJECT:
KC-10A IN-FLIGHT
CABIN NOISE

1/4 1/8 1/16 1/32 1/64 1/128 1/256 1/512 1/1024 1/2048 1/4096 1/8192 1/16384 1/32768 1/65536 1/131072 1/262144 1/524288 1/1048576 1/2097152 1/4194304 1/8388608 1/16777216 1/33554432 1/67108864 1/134217728 1/268435456 1/536870912 1/107374184 1/214748368 1/429496736 1/858993472 1/171798688 1/343597376 1/687194752 1/137438950 1/274877900 1/549755800 1/109951160 1/219902320 1/439804640 1/879609280 1/1759218560 1/3518437120 1/7036874240 1/14073748480 1/28147496960 1/56294993920 1/112589987840 1/225179975680 1/450359951360 1/900719902720 1/1801439805440 1/3602879610880 1/7205759221760 1/1441151844320 1/2882303688640 1/5764607377280 1/1152921475440 1/2305842900800 1/4611685801600 1/9223371603200 1/18446743206400 1/36893486412800 1/73786972825600 1/147573945651200 1/295147891302400 1/590295782604800 1/118059156529600 1/236118313059200 1/472236626118400 1/944473252236800 1/1888946504473600 1/3777893008947200 1/7555786017894400 1/1511157203588800 1/3022314407177600 1/6044628814355200 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1/7530615334566991502027941996953600 1/1506123066913398300405882399387200 1/3012246133826796600811764798774400 1/6024492267653593201623529597548800 1/1204898453530718640324705919501600 1/2409796907061437280649411838983200 1/4819593814122874561298223677966400 1/9639187628245749122584467355932800 1/1927837525649149824516893471185600 1/3855675051298299649033786842371200 1/7711350102596599298067573684742400 1/1542270020519319759613514736948800 1/3084540041038639519227029473897600 1/6169080082077279038454058947795200 1/1233816016415455817690817789590400 1/2467632032830911635381635578180800 1/4935264065661823270763271156361600 1/9870528131323646541526542312723200 1/19741056262647293083053084625446400 1/39482112525294586166106169250892800 1/78964225050589172332212338501785600 1/15792845025117834466442667700357600 1/31585690050235668932885355400715200 1/63171380100471337865770711001430400 1/12634276020094267573154142200285600 1/25268552040188535146308284400571200 1/50537104080377070292616568801142400 1/10107420816075414058523333760228800 1/20214841632150828117046667520457600 1/40429683264301656234093335040915

TABLE: MEASURED SOUND PRESSURE LEVEL (dB)
2 1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT: KC-10A IN-FLIGHT
CREW NOISE

IDENTIFICATION:

OMEGA 3.2

TEST SR-0882-001

RUN 02

02 AUG 82

PAGE F2

FREQ (Hz)	LOCATION/CONDITION														
	9/H	10/H	11/H	12/H	13/H	14/H	15/H	16/H	17/H	18/H	19/H	20/H	21/H	22/H	23/H
25	73	77	77	75	78	76	77	75	76	77	75	76	77	75	76
40	73	73	73	73	73	76	76	76	76	76	76	76	76	76	76
63	73	73	73	73	76	76	77	76	76	76	76	76	76	76	76
98	73	73	73	73	76	76	76	76	76	76	76	76	76	76	76
150	74	74	74	74	75	75	75	75	75	75	75	75	75	75	75
223	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
360	75	70	75	75	75	75	75	75	75	75	75	75	75	75	75
600	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
1000	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
1500	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
2500	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
4000	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
6000	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62
10000	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
15000	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
25000	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
40000	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
50000	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
63000	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
80000	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
100000	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
OVERALL	85	89	91	92	92	92	92	92	92	92	92	92	92	92	92

21.5	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
40	73	77	77	75	78	76	77	75	76	77	75	76	77	75	76
63	73	73	73	73	73	76	76	76	76	76	76	76	76	76	76
98	73	73	73	73	73	76	76	76	76	76	76	76	76	76	76
150	74	74	74	74	74	75	75	75	75	75	75	75	75	75	75
223	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
360	75	70	75	75	75	75	75	75	75	75	75	75	75	75	75
600	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
1000	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
1500	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
2500	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
4000	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
6000	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62
10000	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
15000	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
25000	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
40000	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
50000	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
63000	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
80000	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
100000	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)

2

NOISE SOURCE/SUBJECT:		OPERATION:		LOCATION/CONDITION			
FREQ (HZ)	24/H	1/I	1/J	1/K	1/L	1/M	1/N
25	75	82	80	75	78	79	82
31.5	78	77	80	76	80	79	80
40	75	75	79	76	76	75	82
50	79	77	76	75	77	73	78
63	77	76	75	75	77	73	76
80	76	78	74	80	77	80	76
100	76	78	76	80	78	79	79
125	80	81	83	83	84	73	78
160	80	83	82	84	84	66	74
200	81	73	79	81	67	71	71
250	79	69	77	80	66	71	69
315	78	70	77	78	65	68	68
400	77	68	77	77	69	68	65
500	75	69	77	76	69	66	63
630	76	70	77	78	68	68	65
800	72	75	74	77	70	70	69
1000	68	70	72	76	68	67	65
1250	67	70	72	75	68	67	65
1600	67	67	71	73	65	65	62
2000	65	62	68	71	63	62	65
2500	62	59	65	69	59	59	56
3150	60	57	62	64	56	55	54
4000	56	57	57	60	53	52	52
5000	54	51	54	56	51	49	49
6300	52	50	52	54	50	47	41
8000	52	50	53	54	48	47	46
10000	51	49	52	53	46	45	44
OVERALL	90	90	90	93	89	93	90

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT:	OPERATION:										LOCATION/CONDITION					
	1/A	1/8	1/4	1/2	1/D	1/E	1/F	1/G	1/H	2/H	3/H	4/H	5/H	6/H	7/H	8/H
FREQ (HZ)	31.5	70	80	90	95	96	98	95	94	95	94	91	76	80	80	80
KC-10A IN-FLIGHT	63	69	74	73	91	81	85	81	80	79	73	78	80	80	82	
CREW NOISE	125	67	74	73	87	77	81	80	80	76	75	76	77	77	79	
	250	63	70	70	81	73	72	72	69	69	72	72	71	72	73	
	500	60	65	65	74	69	73	74	72	75	72	76	73	71	73	
	1000	63	68	67	73	69	74	75	72	71	74	74	71	75	74	
	2000	59	64	63	69	65	68	71	67	66	71	73	72	66	68	
	4000	53	59	58	64	63	60	62	58	57	61	64	62	56	57	
	8000	46	51	50	58	62	55	59	51	51	56	61	62	51	52	
OVERALL	75	83	82	98	89	89	88	87	86	85	83	85	84	85	86	

IDENTIFICATION:

OMEGA 3.2

TEST BR-082-001

RUN 01

02 AUG 82

PAGE J1

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT:	OPERATION:	LOCATION/CONDITION														
		9/H	10/H	11/H	12/H	13/H	14/H	15/H	16/H	17/H	18/H	19/H	20/H	21/H	22/H	23/H
FREQ (HZ)																
31.5	81	79	80	85	85	84	84	85	85	86	87	87	88	89	89	86
63	81	82	83	85	85	84	84	85	85	86	86	86	86	86	86	85
125	78	82	82	82	82	85	85	85	85	86	86	86	86	86	86	86
250	71	83	83	84	84	85	85	85	85	86	86	86	86	86	86	85
500	71	81	82	82	82	84	83	83	84	84	85	85	85	84	84	84
1000	71	80	81	81	81	81	81	81	82	81	82	82	82	80	80	75
2000	66	71	71	72	70	69	70	71	70	71	69	70	73	69	69	68
4000	56	61	61	62	59	59	59	59	59	59	61	64	69	63	65	65
8000	51	56	56	56	54	53	53	53	53	53	55	55	58	56	56	55
OVERALL	85	89	92	92	91	93	95	93	95	93	96	97	90	90	91	92

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT: OPERATION:
KC-135 IN-FLIGHT
CREW NOISE

FREQ (HZ)	24/H					LOCATION/CONDITION				
	1/1	1/2	1/4	1/8	1/16	1/M	1/L	1/N	1/O	1/P
31.5	61	64	62	60	59	60	65	61	59	66
63	62	62	60	59	59	60	62	62	74	61
125	64	66	65	65	65	79	75	81	69	77
250	64	76	82	82	82	71	75	74	61	69
500	61	74	81	82	73	73	72	69	71	65
1000	74	77	77	61	73	73	71	61	61	62
2000	70	68	73	76	68	67	65	59	59	61
4000	62	60	63	66	58	57	57	56	56	56
8000	55	54	57	58	53	52	51	45	47	
OVERALL	90	90	90	93	89	93	90	87	87	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

NOISE SOURCE/SUBJECT:		OPERATION:		LOCATION/CONDITION														
				1/H	1/B	1/C	1/D	1/E	1/F	1/G	1/H	2/H	3/H	4/H	5/H	6/H	7/H	8/H
HAZARD/PROTECTION																		
C-WEIGHTED OVERALL SOUND LEVEL (CNSLC IN DB) AT EAR																		
A-WEIGHTED OVERALL SOUND LEVEL (CNLA IN DB) AT EAR																		
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)																		
NO PROTECTION																		
ONSLC	73	81	80	95	87	88	86	85	85	84	82	83	83	84	84	85		
ONSLA	66	71	71	79	74	77	79	75	75	77	77	79	74	77	77	77		
T	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260		
H-157 IN-FLIGHT COMMUNICATION UNIT																		
ONSLAC	50	55	56	70	60	64	62	61	60	59	59	59	59	60	62	62		
T	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260		
COMMUNICATION PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)																		
PSIL	51	66	65	72	69	72	73	70	71	72	74	73	69	72	72	72		
ANNOYANCE																		
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PMDB)																		
TONE CORRECTION (C IN DB)																		
PNLT	80	86	85	95	89	91	91	89	90	90	93	92	86	90	89			
C	2	1	2	1	1	1	1	1	2	0	1	1	0	1	0	0		

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

NOISE SOURCE/SUBJECT:		OPERATION:		LOCATION/CONDITION			
24/H	1/H	1/J	1/K	1/L	1/M	1/N	1/O
OAGLC	89	90	92	87	90	87	89
OAGLA	81	79	83	85	76	74	70
H-157 IN-FLIGHT COMMUNICATION UNIT	807	960	571	404	960	960	960
OAGLA	68	66	69	70	61	64	59
PSPIL	960	960	960	960	960	960	960

COMMUNICATION

PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)
PSPIL 75 73 77 80 71 71 68 64 62

ANNOYANCE

PERCEIVED NOISE LEVEL, TONE CORRECTED (PMLT IN DB)
TONE CORRECTION (C IN DB)
PMLT C 94 94 95 97 89 89 89 84 84
C 0 2 1 0 1 0 1 1 2 1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.